Patent
Customer No.: 006980
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of Assignee:

GEORGIA TECH RESEARCH CORP.

Patent No.: 5,974,869

Issued: 2 November 1999

For: **NON VIBRATING CAPACITANCE PROBE FOR WEAR MONITORING**

REISSUE PRELIMINARY AMENDMENT

Box Patent Application
Commissioner of Patents
Washington, DC 20231

Atlanta, GA 30308

1 May 2001

Sir:

Prior to examining the enclosed Reissue Application, please enter the following amendments:

IN THE CLAIMS

Please add new Claims 11-28 as follows (*a clean sheet of Claims pending upon entrance of this Preliminary Amendment is presented in Appendix A*):

11. (new) A non-contact detector for measuring a property of a sample comprising, a sensor being in electrical communication with a sample, the sample and the sensor having different work functions and being separated from one another by a characteristic distance, and a measurement device for measuring a current related to a contact potential difference between the sample and the sensor, thereby measuring a property of the sample.

12. (new) The non-contact detector of Claim 11, the sensor being a non-vibrating sensor.

13. (new) A non-contact detector for measuring at least one of chemical properties and tribological wear of a component comprising:

(a) a sensor having a sensor work function, the sensor being in proximity to the component at a selected distance from the component, and the component having a component work function; and

(b) a measurement device for measuring a temporal variation in a property relatable to the component work function.

14. (new) The non-contact detector of Claim 13, the sensor work function being different than the component work function.

15. (new) The non-contact detector of Claim 14, the measurement device for measuring the temporal variation in the component work function wherein the property is determined by measuring an induced current which is related to a temporal change in contact potential difference between the component and the sensor.

16. (new) An apparatus for monitoring surface changes on a component, said apparatus comprising:

(a) a non-vibrating capacitance probe;

(b) a placement device for positioning the non-vibrating capacitance probe in proximity to the component; and

(c) a first measurement device for measuring a property which is relatable to the contact potential difference between the component and the non-vibrating capacitance probe.

17. (new) An apparatus according to claim 16, further comprising a second measurement device for measuring the relative motion between the component and the non-vibrating capacitance probe.

18. (new) An apparatus according to claim 17, further comprising a regulator capable of regulating the relative motion between the component and the non-vibrating capacitance probe.

19. (new) An apparatus according to claim 16, further comprising a third measurement device for measuring a nearest spatial distance between the component and the non-vibrating capacitance probe.

20. (new) An apparatus according to claim 16, further comprising a support for supporting the component.

21. (new) An apparatus according to claim 20, wherein the placement device for positioning the non-vibrating capacitance probe in proximity to the component is fixed relative to the support.

22. (new) A capacitance probe for measuring at least one property of a sample, comprising:

(a) a reference electrode and a sample forming at least part of an electrical circuit, the reference electrode disposed adjacent the sample and having a characteristic closest separation distance between the sample and the reference electrode, the reference electrode maintained substantially fixed during measurement of the at least one property, and the sample and the reference electrode forming a capacitor element of the electrical circuit;

(b) a voltage source coupled to the reference electrode and being part of the electrical circuit; and

(c) a device for measuring current induced by activating the voltage source in the electrical circuit.

23. (new) The capacitance probe of Claim 22, the reference electrode being a non-vibrating reference electrode.

24. (new) A non-contact detector for measuring at least one of tribological wear and chemical changes of a sample comprising, a non-vibrating sensor being in electrical communication with a sample, the sample and the sensor having different work functions and being separated from one another by a selected distance of closest approach and a measurement device for measuring a current related to a time varying change in the selected distance of closest approach between the sample and the sensor, thereby measuring the at least one of tribological wear and chemical changes of the sample.

25. (new) The non-contact detector of Claim 24 wherein the tribological wear comprises mechanical defect surface variations of the sample.

26. (new) A method of sensing at least one of chemical properties and tribological wear of a sample comprising the steps of:

(a) positioning a non-vibrating sensor in proximity to the sample, the sensor being separated by a selected distance from the sample; and

(b) measuring a current related to a contact potential difference between the sample and the sensor.

27. (new) The method according to Claim 26, further comprising step (c) of imparting

relative motion between the sample and the sensor.

28. (new) A method of sensing at least one of chemical properties and tribological wear of a sample comprising the steps of:

(a) locating a non-vibrating sensor having a sensor work function in proximity to the sample having a sample work function, the sensor being separated by a selected distance from the sample;

(b) measuring an induced current between the sample and the sensor; and

(c) determining at least one of chemical properties and tribological wear of the sample by relating the induced current to at least one of (i) a difference between the sensor work function and the sample work function and (ii) a variation in the selected distance from the sample.

IN THE SPECIFICATION

Please amend the Specification as follows (*a clean sheet of the amended paragraphs upon entrance of this Preliminary Amendment is presented in Appendix B*):

Column 2, line 51, please change "fimction" to --function--;

Column 3, lines 20 - 22, please delete the entire paragraph beginning with "FIG. 2 is a graph …" and ending in "… materials A and B." and substitute therefore --Fig. 2a is a diagram of the scanning of a reference electrode and rotating cylindrical surface composed of materials A and B according to the present invention.

Fig. 2b is a graph of the CDP variation measured by the present invention of the reference electrode and rotating cylindrical surface composed of materials A and B of Fig. 2a.—

Column 4, line 67, please delete "Fig. 2" and substitute therefore --Fig. 2a--.

Column 5, line 1, please delete "Fig. 2" and substitute therefore --Fig. 2a--.

Column 5, line 10, please delete "Fig. 2" and substitute therefore --Fig. 2b--.

Column 6, line 37, please delete "Fig. 2" and substitute therefore --Fig. 2a--.

REMARKS

The inventors and the Assignee of U.S. Patent No. 5,974,869 to Danyluk et al. (the "'869 Patent") file the present Reissue Preliminary Amendment concurrent with a Reissue Application for the '869 Patent. A clean set of the pending claims of the Reissue, and of the amended paragraphs of the Specification, are attached hereto as Appendices A and B, respectfully. The '869 Patent was filed 14 November 1997, issued 2 November 1999, and claims priority to Provisional Application No. 60/030,814 filed 14 November 1996.

The Reissue Application reopens the prosecution of the '869 Patent in order to:

1. Correct what is believed as a partially defective Specification;
2. Present new Claims of different scope than those of the '869 Patent; and
3. Submit prior art references that have recently come to the attention of the inventors and Assignee.

Partially Defective Specification

The '869 Claims were deemed allowable in a First Office Action and issued without amendments in the same form as they were initially filed in the Application. The Drawings of the '869 Patent were objected to in the Notice of Allowability (PTOL-85). In response to the Notice of Draftpersons's Patent Drawing Review mailed along with PTOL-85, Applicants in a 312 Amendment filed on 11 May 1999 requested that:

i. Fig. 2 be deleted as originally submitted and substituted with Fig. 2a and Fig. 2b; and

ii. At page 4 of the Application as filed, delete lines 15 and 16 and substitute therefore -- Fig. 2a is a diagram of the scanning of a reference electrode and rotating cylindrical surface composed of materials A and B according to the present invention.

Fig. 2b is a graph of the CDP variation measured by the present invention of the reference electrode and rotating cylindrical surface composed of materials A and B of Fig. 2a.--

At page 6, line 25 delete "Fig. 2" and substitute therefore --Fig. 2a--.
At page 6, line 26 delete "Fig. 2" and substitute therefore --Fig. 2a--.
At page 7, lines 8 and 9 delete "Fig. 2" and substitute therefore --Fig. 2b--.
At page 9, line 4 delete "Fig. 2" and substitute therefore --Fig. 2a--.

Although the Examiner indicated in a Response to the Applicants' 312 Amendment that the above changes had been entered, only the Drawing changes were made, and not the textual changes to the Specification. These non-entered textual changes are submitted by this Reissue.

A typographical error found in the '869 Patent also is corrected by this Reissue.

New Claims

The '869 Patent issued with ten (10) Claims, two (2) of which were independent Claims. Seven (7) Claims were drawn to an apparatus, and three (3) to a process. As noted above, all Claims were allowed as filed.

For clarity, Applicants illustrate at least some of the differences in Claim language between the '869 Patent Claims, and the newly presented Reissue Claims, element by element, in order to demonstrate differences in scope.

Apparatus Claims 1-7 of the '869 Patent comprise at least three or more of the following elements ($\mathbf{i}_{AP}$.= element **i** of apparatus '869 Patent Claim):

$\mathbf{i}_{AP}$ a non-vibrating capacitance probe;

$\mathbf{ii}_{AP}$ a means for positioning the probe in proximity to a component;

$\mathbf{iii}_{AP}$ a means for measuring the contact potential difference between the component and the non-vibrating capacitance probe; and

$\mathbf{iv}_{AP}$ other means plus function language.

Process Claims 8-10 of the '869 Patent comprise at least the following three elements ($\mathbf{i}_{MP}$ = element **i** of method/process '869 Patent Claim):

$\mathbf{i}_{MP}$ imparting relative motion to a non-vibrating capacitance probe;

$\mathbf{ii}_{MP}$ monitoring the relative motion; and

$\mathbf{iii}_{MP}$ monitoring the contact potential difference between the component and the non-vibrating capacitance probe.

The following elements of the newly presented Reissue Claims differ in scope from the similarly numbered elements of the Claims of the '869 Patents. For example, above-identified element $\mathbf{i}_{AP}$ (of the apparatus claims of the '869 Patent) is compared with below-identified element $\mathbf{i}_{AR}$ (of the apparatus claims of the presently added Reissue Claims). Applicants respectfully submit that the '869 Patent supports claims to an apparatus comprising ($\mathbf{i}_{AR}$ = element **i** of apparatus Reissue Claim):

$\mathbf{i}_{AR}$ 1. "... the sample and the sensor ... being separated from one another by a characteristic distance ..." (supported in the '869 Patent Specification and Drawings, specifically Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (element of new Reissue Claims 11 and 12);

2. "... the sensor being in proximity to the component at a selected distance from the component ..." (specifically, Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claims 13-15 and 26-28);

3. "... the non-vibrating probe in proximity to the component ..." (specifically Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claims 16-21);

4. "... the reference electrode disposed adjacent the sample ..." (specifically Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claims 22 and 23);

5. "... a characteristic closest separation distance between the sample and the reference electrode ..." (specifically Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claims 22 and 23);

6. "... the sample and the sensor ... being separated from one another by a selected distance of closest approach ..." (specifically Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claims 24 and 25);

ii$_{AR}$ means for positioning not a necessary element (new Reissue Claims 11-15, 22-25);

iii$_{AR}$ 1. "... a measurement device for measuring a current ..." (specifically Col. 2, lines 16-19, lines 31-37, lines 48-52; Figs. 5 and 6) (new Reissue Claims 11 and 12, 22-25);

2. "... a measurement device for measuring a temporal variation in a property relatable" to work function (specifically Col. 2, lines 20-24; Figs. 5 and 6) (new Reissue Claims 13-15);

3. "... a [] measurement device for measuring a property which is relatable to [] contact potential difference..." (specifically Col. 2, lines 16-19, lines 48-52; Figs. 5 and 6; Claims 1-10) (new Reissue Claims 16-21);

iv$_{AR}$ no means plus function language (new Reissue Claims 11-25).

Thus it can be seen that new Reissue Claims 11-25 presented in this Reissue Application are all fully supported by the '869 Patent, and are of different scope than Claims 1-7 of the '869 Patent.

Similarly, as to newly presented method Reissue Claims, Applicants respectfully submit that the '869 Patent supports claims to a method comprising ($\mathbf{i}_{MR}$ = element **i** of method/process Reissue Claim):

$\mathbf{i}_{MR}$ 1. imparting relative motion not a necessary element (new Reissue Claims 26 and 28);

$\mathbf{i}_{MR}$ 2. "... positioning a non-vibrating sensor in proximity to the sample, the sensor being separated by a selected distance from the sample ..." (specifically, Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claims 26 and 27);

3. "... locating a non-vibrating sensor ... in proximity to the sample ..., the sensor being separated by a selected distance from the sample ..." (specifically, Col. 1, lines 17-24 ([t]he present invention generally relates to *non-contact* sensors ...(i.e. separated by a distance)); Col. 2, lines 12-14; Col. 4, lines 40-45; Figs. 1, 2a, 5 and 6; Claims 1-7) (new Reissue Claim 28);

$\mathbf{ii}_{MR}$ monitoring the relative motion not a necessary element (new Reissue Claims 26-28); and

$\mathbf{iii}_{MR}$ 1. "... measuring a current related to contact potential difference ..." (specifically Col. 2, lines 16-19; lines 31-37; Figs. 1-10) (new Reissue Claims 26 and 27);

2. "... measuring an induced current ..." (specifically Col. 2, lines 16-19; lines 31-37; Figs. 1-10) (new Reissue Claim 28);

Thus it can be seen that new Reissue Claims 26-28 presented in this Reissue Application are all fully supported by the '869 Patent, and are of different scope than Claims 8-10 of the '869 Patent.

Prior Art

U.S. Patent Nos. 4,481,616 to Matey and 5,136,247 to Hansen are submitted for the Examiner's review.

CONCLUSION

By the present Preliminary Amendment, the Reissue Application is believed to be in condition for allowance. Accordingly, Applicants respectfully request early and favorable action. Should the Examiner have any questions or reservations regarding the present Preliminary Amendment, the Examiner is invited to telephone the undersigned attorney at 404.885.2773.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Honorable Commissioner for Patents, Box ~~New App.~~ Reissue Washington, D.C. 20231 on 5/1/2001

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Name of Applicant Assignee, or Registered Representative

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The Commissioner is hereby authorized to charge any additional fees that are required, or credit any overpayment, to Deposit Account No. 20-1507.

APPENDIX A

Clean Set of Claims pending upon entrance of this Preliminary Amendment:

1. An apparatus for monitoring surface variations on a component, said apparatus comprising:

(a) a non-vibrating capacitance probe;

(b) means for positioning said non-vibrating capacitance probe in proximity to the component; and

(c) means for measuring the contact potential difference between the component and said non-vibrating capacitance probe.

2. An apparatus according to claim 1, further comprising a means for measuring the relative motion between the component and said non-vibrating capacitance probe.

3. An apparatus according to claim 2, further comprising means for regulating the relative motion between the component and said non-vibrating capacitance probe.

4. An apparatus according to claim 1, further comprising means for measuring the spatial distance between the component and said non-vibrating capacitance probe.

5. An apparatus according to claim 1, further comprising a means for supporting the component.

6. An apparatus according to claim 5, wherein said means for positioning said non-vibrating capacitance probe in proximity to the component is fixed relative to said means for supporting the component.

7. An apparatus according to claim 1, wherein said surface variation is surface wear.

8. A process for monitoring surface variations on a component, comprising the following steps:

(a) imparting relative motion between the component and a non-vibrating capacitance probe;

(b) monitoring the relative motion between the component and the non-vibrating capacitance probe; and

(c) monitoring the contact potential difference between the component and the non-vibrating capacitance probe.

9. A process according to claim 8, further comprising the step of monitoring the distance between the said test surface and the non-vibrating capacitance probe.

10. A process according to claim 9, wherein the surface variation is surface wear.

11. A non-contact detector for measuring a property of a sample comprising, a sensor being in electrical communication with a sample, the sample and the sensor having different work functions and being separated from one another by a characteristic distance, and a measurement device for measuring a current related to a contact potential difference between the sample and the sensor, thereby measuring a property of the sample.

12. The non-contact detector of Claim 11, the sensor being a non-vibrating sensor.

13. A non-contact detector for measuring at least one of chemical properties and tribological wear of a component comprising:

(a) a sensor having a sensor work function, the sensor being in proximity to the component at a selected distance from the component, and the component having a component work function; and

(b) a measurement device for measuring a temporal variation in a property relatable to the component work function.

14. The non-contact detector of Claim 13, the sensor work function being different than the component work function.

15. The non-contact detector of Claim 14, the measurement device for measuring the temporal variation in the component work function wherein the property is determined by measuring an induced current which is related to a temporal change in contact potential difference between the component and the sensor.

16. An apparatus for monitoring surface changes on a component, said apparatus comprising:

(a) a non-vibrating capacitance probe;

(b) a placement device for positioning the non-vibrating capacitance probe in proximity to the component; and

(c) a first measurement device for measuring a property which is relatable to the contact potential difference between the component and the non-vibrating capacitance probe.

17. An apparatus according to claim 16, further comprising a second measurement device for measuring the relative motion between the component and the non-vibrating capacitance probe.

18. An apparatus according to claim 17, further comprising a regulator capable of regulating the relative motion between the component and the non-vibrating capacitance probe.

19. An apparatus according to claim 16, further comprising a third measurement device for

measuring a nearest spatial distance between the component and the non-vibrating capacitance probe.

20. An apparatus according to claim 16, further comprising a support for supporting the component.

21. An apparatus according to claim 20, wherein the placement device for positioning the non-vibrating capacitance probe in proximity to the component is fixed relative to the support.

22. A capacitance probe for measuring at least one property of a sample, comprising:

(a) a reference electrode and a sample forming at least part of an electrical circuit, the reference electrode disposed adjacent the sample and having a characteristic closest separation distance between the sample and the reference electrode, the reference electrode maintained substantially fixed during measurement of the at least one property, and the sample and the reference electrode forming a capacitor element of the electrical circuit;

(b) a voltage source coupled to the reference electrode and being part of the electrical circuit; and

(c) a device for measuring current induced by activating the voltage source in the electrical circuit.

23. The capacitance probe of Claim 22, the reference electrode being a non-vibrating reference electrode.

24. A non-contact detector for measuring at least one of tribological wear and chemical changes of a sample comprising, a non-vibrating sensor being in electrical communication with a sample, the sample and the sensor having different work functions and being separated from one another by a selected distance of closest approach and a measurement device for measuring a current related to a time varying change in the selected distance of closest approach between the sample and the sensor, thereby measuring the at least one of tribological wear and chemical changes of the sample.

25. The non-contact detector of Claim 24 wherein the tribological wear comprises mechanical defect surface variations of the sample.

26. A method of sensing at least one of chemical properties and tribological wear of a sample comprising the steps of:

(a) positioning a non-vibrating sensor in proximity to the sample, the sensor being separated by a selected distance from the sample; and

(b) measuring a current related to a contact potential difference between the sample and the sensor.

27. The method according to Claim 26, further comprising step (c) of imparting relative motion between the sample and the sensor.

28. A method of sensing at least one of chemical properties and tribological wear of a sample comprising the steps of:

(a) locating a non-vibrating sensor having a sensor work function in proximity to the sample having a sample work function, the sensor being separated by a selected distance from the sample;

(b) measuring an induced current between the sample and the sensor; and

(c) determining at least one of chemical properties and tribological wear of the sample by relating the induced current to at least one of (i) a difference between the sensor work function and the sample work function and (ii) a variation in the selected distance from the sample.

APPENDIX B

Rewritten Specification Paragraphs With Above Changes Incorporated:

Column 2, lines 38-57

In one embodiment of the apparatus, the component to be monitored for surface variations either is a cylindrical shaft composed of the material to be monitored, or wear-tested, or is a cylindrical shaft coated with the material to be monitored, or wear-tested. The component is supported by roller bearings on both ends of the shaft, allowing rotation of the shaft along its axis. The shaft is rotated by a motor and the rotational speed of the shaft is monitored. A non-vibrating capacitance probe is mounted on an xyz-positioning system, and a monitor detects the spacing between the shaft surface and probe. A monitoring device interprets the current induced in the non-vibrating capacitance probe as a difference in work function between the component and the known work function of the reference electrode in the probe. The process of measuring the work function of the component comprises the creation of relative rotational motion between the component and the non-vibrating capacitance probe. The relative motion of the component and probe, and the distance between the component and probe also are monitored.

Column 3, lines 20 - 22 (Paragraph deleted and replaced with the following)

Fig. 2a is a diagram of the scanning of a reference electrode and rotating cylindrical surface composed of materials A and B according to the present invention.

Fig. 2b is a graph of the CDP variation measured by the present invention of the reference electrode and rotating cylindrical surface composed of materials A and B of Fig. 2a.

Column 4, line 67 - Column 5, line 4

One embodiment of the present invention is the scanning of a cylinder 30 having a cylindrical surface 20 rotating along its longitudinal axis 22, as shown in FIG. 2a. Using the geometry depicted in FIG. 2a, along the circumference of the cylinder 30, part of the surface 20 consists of material A, and the rest of the surface 20 consists of material B; each material having a unique work function.

Column 5, lines 5 - 11

As the cylinder 30 rotates at a constant speed, the reference electrode 40 senses a contact potential difference with material A, CPD_{EA}, and another potential with material B, CPD_{EB}. Also assume that CPD_{EB} is zero. The variation in the CPD with time can be described by a rectangular wave function V(t) with an amplitude CPD_{EA}, as shown in FIG. 2b. The Fourier series of the function is

Column 6, lines 27 - 46

FIG. 7a shows an example of signal output for the silver strip 170 with a length fraction of 0.013. The signal exhibits a series of large waves, separated by fluctuations with smaller amplitudes. This pattern is identical to that of the theoretical signal which is calculated for a similar length fraction, shown in FIG. 3a. The time interval between the large waves corresponds to the rotational frequency of the shaft 100. The interval between the maximum and minimum peaks of each wave packet represents the traverse of the probe 150 along the arc length of the silver strip 170. As per FIG. 2a, upon entry into the silver strip 170, the reference electrode 152 senses an abrupt shift in the contact potential difference from aluminum to silver. At this point, the rate of change in CPD, ie., dV/dt, is maximum (equation 7). As the reference electrode 152 moves from silver to aluminum, it senses another sharp change in CPD but with a dV/dt of reverse polarity. In accordance with this model, the interval between the maximum and minimum points of the large peaks is longer for the silver strip 170 with a length fraction of 0.3, shown in FIG. 7b.